Nitrogen Budget for the Strait of Georgia

Paul J. Harrison
University of British Columbia

Abstract

The nitrogen budget for the Strait of Georgia has been estimated, and this budget is used to assess the potential for eutrophication of this system by anthropogenic nutrient inputs. The exchange of water by estuarine and tidal currents is rapid, and water in the Strait is estimated to turnover about once per year. Waters entering the strait carry naturally high nitrogen concentrations, and therefore natural nitrogen inputs from estuarine circulation are about one order of magnitude higher than inputs from sewage, rivers, groundwater discharge, and atmospheric contributions. The largest loss term for nutrients is the estuarine exchange, which may be influenced by variations in the Fraser River discharge and offshore oceanographic conditions (affects nitrogen concentrations of the incoming deep water). Sensitivity to anthropogenic nutrient addition varies with location. The most sensitive regions are inlets and fjords that have low flushing rates and adjacent urban centers.

Assessing Sensitivity to Eutrophication Using PSAMP Long-Term Monitoring Data from the Puget Sound Region

Jan Newton, Storrs Albertson, Casey Clishe, Margaret Edie, Carol Falkenhayn, and John Summers
Washington State Department of Ecology

Abstract

Puget Sound is an extremely complex and diverse environment, since it is a composite of bays, inlets, deep basins, and channels. Certain localized areas within Puget Sound are susceptible to eutrophication while others are not. This difference is largely driven by physical processes such as mixing and advection. At the same time of the year, Puget Sound phytoplankton growth is light-limited in some areas and nutrient-limited in others. Understanding the mechanisms driving primary production is key to assessing impacts of anthropogenic alterations, such as nutrient inputs. The degree of persistence of the density stratification is found to be a good indicator of sensitivity to eutrophication and low dissolved oxygen in the bottom waters. As part of the Puget Sound Ambient Monitoring Program, the Marine Waters Monitoring group at the Washington State Department of Ecology collects monthly monitoring data from various locations in the greater Puget Sound region. It has been possible to characterize sub-regions and localized areas in terms of their physical stability and biological productivity. Monitoring data in combination with targeted experiments have proven useful for assessing eutrophication sensitivity in the various regions of Puget Sound.

Effects of Elevated Nutrients from Fish Farm Wastes on Phytoplankton Productivity

J. Roderick Forbes
Department of Fisheries and Oceans Canada

Edward A. Black
Ministry of Agriculture, Fisheries, and Food

Abstract

The potential impact of wastes from salmon aquaculture operations on biological production has been evaluated by four approaches: nutrient uptake rates and their role in utilization of nitrogenous farm wastes; the relative contribution fish farms make to available nitrogenous stocks and fluxes; the maximum phytoplankton biomass that could be released from fish farm wastes; and ecologically resolved phytoplankton production from nitrogen. Estimates calculated by each approach indicate the impact of these wastes is small in comparison to natural and other anthropogenic sources of nitrogen input. This results suggests that the industry in British Columbia is unlikely to have a significant impact at current production levels, although there is potential for local effects in areas of poor circulation or where net pens interfere with local current patterns. Further evaluation should consider whether increased nutrient concentrations would be sufficient to stimulate harmful blooms or whether, through changing nutrient ratios, there could be shifts such as from a diatom- to a flagellate-dominated community structure. There may be value in establishing scientifically based standards to which predicted impacts could be related, prior to development. Such evaluations require quantification of the amounts of wastes generated, the use of numerical models to predict impact, and the establishment of specific ecological standards or targets.

Interdecadal Variations in Developmental Timing of the Copepod *Neocalanus plumchrus* (Marukawa) in the Strait of Georgia

E.A. Bornhold and P.J. Harrison
University of British Columbia

D. L. Mackas
Department of Fisheries and Oceans Canada

Abstract

In coastal waters of the North Pacific, copepods of the genus *Neocalanus* dominate the spring and early summer mesozooplankton community. All *Neocalanus* species undergo a very strong seasonal vertical migration that is closely linked to their developmental cycle. In the Strait of Georgia (49_–50_N, 123_–125_W), the 30–50 day annual peak of mesozooplankton biomass has historically coincided with maximum surface layer abundance of maturing large *Neocalanus plumchrus* copepodites (C4 and pre-migrant C5). We present evidence for significant changes in the timing of the vertical migration component of the *N. plumchrus* life cycle during the past 25–30 years. In the Strait of Georgia, the developmental cycle is now about 25–30 days earlier than it was 30 years ago, with peak biomass now occurring in mid-April (compared to mid-May previously). The variability in timing, which appears to be coincident with warming trends in both surface and over-wintering deep water, is likely to be ecologically significant because it shifts relatively narrow seasonal windows of maximum grazing pressure on 10–50 mm prey, and it influences the availability of large copepodites to upper ocean predators such as salmon, herring, and hake.